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Lecture Notes for Slide Series

THE SCREW-WORM. . . a parasite of livestock

Introduction

The screwworm is the maggot of a fly called Callitroga hominivorax (Coquerel) by entomologists. It may infest any warm-blooded animals and is one of the worst parasitic insect pests of livestock. It has caused losses estimated at \$20 million annually in the Southeastern States—\$10 million in Florida alone— in animals killed, deformed, and made more susceptible to disease; in loss of weight; and in the expense of extra labor and medication.

In 1954, scientists of the U. S. Department of Agriculture eradicated the screwworm from the Caribbean Island of Curacao by releasing laboratory-reared flies sterilized by exposing them to radioactive cobalt, a product of nuclear energy research. Native females, mated with sterile males, caused them to produce only infertile eggs, and as the released sterile males outnumbered the native males, the species was exterminated in about 6 months. This method is aided by the fact that the female screwworm fly mates only once.

Prior to the Curacao program the method was tested on Sanibel and

Captiva Islands, off the Coast of Florida, in 1951-53. In 1957, it was found effective again in a 2000-square-mile area near Orlando, Florida. Based on these tests, the U. S. Department of Agriculture, in cooperation with state agencies in Florida, Georgia, South Carolina, Alabama and Mississippi, have undertaken a full-scale program to eradicate the screwworm from southeastern United States. Other states cooperating closely with the program are Tennessee, Arkansas and Louisiana.

Laboratory-reared, sterile flies are released by airplanes at the rate of about 50 million per week over the eradication area. Eradication activities are taking place largely in Florida where the greatest number of infestations occur and where the fly can overwinter. However, operations have been extended into southeastern Alabama and southern Georgia where a number of infestations were discovered in 1958. These zones comprise a total area of about 70,000 square miles, and has been as high as 84,400 square miles.

To hasten eradication of this serious pest, livestock owners in the Southeast are urged to use approved methods to reduce screwworm populations by treating and reporting infestations promptly.

Screwworms are native to Texas, New Mexico, Arizona and California and southward into Central and South America. However, they did not exist in southeastern United States until 1933 when they appeared in Georgia, apparently shipped in with infested cattle from the Southwest. That year, the fly spread southward into Florida where it could thrive throughout the year. The flies have been known to migrate northward as

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Scatterings are native to Texas, New Mexico, Arizona and California and scattered into Central and South America. However, they did not exist in southeastern United States until 1933 when they appeared in Georgia, apparently shipped in with infested cattle from the Southwest. That year, the fly spread southward into Florida where it could thrive throughout the year. The flies have been known to migrate southward as

far as Virginia and Tennessee and may be transported with infested animals much further north. Similarly, the flies migrate northward seasonally into the West and Midwest from the Mexican border regions. They overwinter in Peninsular Florida and subtropical areas of the Southwest.

During and after eradication, it will be necessary to protect the Southeastern States from reinfestation. Federal inspection stations have been established along the eastern borders of Arkansas and Louisiana to inspect animals for screwworms and treat them, if necessary, before they are permitted into the southeastern area. Florida maintains a quarantine line across the central part of the State and livestock are sprayed before shipment out of the infested areas.

Life Cycle

1 - A program symbol showing the relationship of the screwworm fly to nuclear energy.

2 - The female fly is on the right, the male on the left. The flies are about twice the size of the housefly, metallic blue in color with brick red heads. The flies feed on nectar of flowers and live several weeks. The females also feed on any type of wounds in wild and domestic, warm-blooded animals and deposit eggs on the wounds. Compared with other flies, they are not abundant in nature. They do not bite; nor are they household or picnic pests.

3 - Here a female screwworm fly is depositing her eggs in a typical, shingle-like mass. She lays about 250 eggs at a time on a wound and can lay several egg masses in her lifetime. The eggs hatch in 12-24 hours.

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3 - Here a female screwworm fly is depositing her eggs in a syringe, which-like mass. She lays about 250 eggs at a time on a wound and can lay several egg masses in her lifetime. The eggs hatch in 12-24 hours.

4 - These are partially grown maggots or larvae. Full grown larvae are $\frac{1}{2}$ to $\frac{3}{4}$ of an inch long. The tapered shape and spines encircling the larvae suggest a wood screw-hence the name "screwworm". The larvae bury themselves in the wound with only their rear ends protruding. In nature, they feed only on living flesh. With hook-like mouthparts they ¹¹acerate the tissue, causing it to bleed and exude serum upon which they feed. Such a wound may be reinfested with more screwworms; or with other blowfly maggots which crawl over the wound, feeding on dead matter. The screwworm remains in the wound an average of 5 days, when it drops to the ground, burrows in and forms a pupa~~x~~ in the soil.

5 - These are pupae of the insect showing various ages: the light-colored forms are the youngest; the darkest in the center is a pupa from which the fly is ready to emerge. They remain in this stage for 5 to 14 days, depending on temperature, moisture and other conditions of the soil. Low temperature retards development.

6 - A favorite site for depositing eggs is the navel of newborn animals. Screwworms feeding here often permit entrance of organisms that later cause swollen joints and other deformities if the animal lives. If not treated promptly such wounds become reinfested, causing death of the animal.

7 - Any type of break in the skin can attract screwworm infestations: wire cuts, horsefly and tick bites, wounds from surgical operations, and livestock practices such as ear-marking, castrating, dehorning and others. The wounds produce a characteristic reddish, **malodorous** discharge. A wound such as this, left untreated invites further infestations and can kill a

1 - These are partially grown maggots or larvae. Full grown larvae are $\frac{1}{2}$ to $\frac{3}{4}$ of an inch long. The tapered shape and spinous covering the larvae suggest a wood sawfly. The larvae bury themselves in the wound with only their rear ends protruding. In nature, they feed only on living flesh. With hook-like mouthparts they sever the tissue, causing it to bleed and exude serum upon which they feed. Such a wound may be reinfected with more maggots; or with other highly sensitive which crawl over the wound, feeding on dead matter. The maggots remain in the wound an average of 5 days, when it drops to the ground, but may in and forms a pupa in the soil.

2 - These are pupae of the insect showing various ages. The light-colored forms are the youngest; the darkest in the center is a pupa from which the fly is ready to emerge. They remain in this stage for 5 to 10 days, depending on temperature, moisture and other conditions of the soil. Low temperature retards development.

3 - A favorite site for depositing eggs is the nasal or nostril cavity. Sawflies feeding here often produce a swelling of the nostril which causes swelling of the face and other deformities in the animal. If not treated promptly even wounds become reinfected, causing death of the animal.

4 - Any type of break in the skin can attract sawfly infestation; wire cuts, horsefly and tick bites, wounds from surgical operations, and livestock practices such as ear-marking, castrating, branding and others. The wounds produce a characteristic reddish, malodorous discharge. A wound such as this, left untreated invites further infestation and can kill a

full grown steer in 10 days.

8 - The use of the fly trap assists in determining the incidence and location of the screwworm fly; although surveys and reports of infestations are most essential to this program. The trap¹ are placed in partially-shaded spots and baited with liver in the pan shown at the right of the trap.

9 - The traps collect many species of flies and other insects. The inspector, here, has placed the trap inside a bag and is fumigating the whole with methyl bromide to kill the insects. The collection will then be placed in a properly labeled container, which is delivered to the laboratory for identification of the species.

10 - The screwworm fly is difficult to distinguish from some other species of flies caught in traps, and screwworm larvae can be distinguished from other larvae only by examining specimens under the microscope. A method has been devised to differentiate native flies from sterile flies reared in a laboratory. Here an entomologist is at work identifying some specimens.

11 - From surveys and reports of screwworm cases, the northernmost occurrence of the fly during the winter can be determined quite accurately. Note how many times the most northerly overwintering line has been confined to Peninsular Florida. This information was significant in establishing a program to eradicate the screwworm from the Southeast. Before this program was undertaken, tests were conducted to determine the feasibility of eradication in isolated areas.

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11 - Using the sterile flies, tests were conducted on Sanibel and Captiva Islands off the coast of Florida in 1951-52. Although the islands were reinfested by screwworm flies from the mainland, the method showed great promise. In 1954, the method was used to eradicate the screwworm from the Island of Curacao off the coast of Venezuela. To train personnel and improve equipment, a 2000-square-mile area near Orlando Florida was treated in 1957. The present program was established on the success of these tests.

12 - In 1957, one of the worst years for screwworms in the Southeast, the infestations spread to Mississippi on the west and to Virginia in the north. With the help of a cold winter in 1957-58 and with the release of sterile flies, the most northerly migration of the fly was limited to extreme southern Georgia in 1958. Infestations which occurred in central Alabama, and a few cases reported in Mississippi were believed to have been caused by infested animals shipped into these areas.

14 - The estimated eradication area ~~shown here has been revised to~~ ^{was expanded to} include southeastern Alabama where sterile flies were released during the fall of 1958.

15 - Rearing and sterilizing sufficient flies to distribute over the 70,000 square mile eradication area require enormous laboratory facilities. This airplane hangar at the Sebring Air Terminal, Sebring Florida, has been modified for that purpose. The building has 100,000 square feet of working space on two levels. The structure is sealed throughout, and extreme security measures are enforced to prevent the escape of any fertile

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13 - The estimated eradication area shown here has been limited to
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14 - Testing and sterilizing facilities are distributed over the
 70,000 square mile eradication area through various laboratory facilities.
 This airplane hangar at the Boeing Air Terminal, Sebring Florida, has
 been modified for that purpose. The building has 100,000 square feet of
 working space on two levels. The structure is sealed throughout, and
 extreme security measures are enforced to prevent the escape of any fertile

flies. The fly-rearing is on a 24-hour, 7-day week schedule.

16 - The rearing process begins on the upper level of the laboratory. This diagram shows the arrangement. The pink area indicates the fly colony which is maintained to produce the required number of eggs. The yellow lines represent monorails on which 1000 3-tiered racks with vats of rearing media are transported through the process. The white "X's" show the positions of huge funnels which collect the larvae as they mature and crawl over the edges of the vats and fall through grates in the floor. The funnels carry the larvae to the first floor. The green area shows the air duct which removes the ~~stale~~^{foul} air.

17 - Inside the fly colony room are a number of large screen cages as indicated here. The room is darkened at all times. The eggs are deposited on a special mixture of ground meat and blood serum placed in the bottom of the cage.

18 - Here an attendant hangs streamers of paper toweling on which the flies rest. The flies are given a special diet of honey, water, and ground meat.

19 - The eggs are removed from the special media on which they are laid. The egg masses appear as white blotches. After the eggs are removed they are then weighed in 5-gram batches before they are placed on moist paper to hatch in about 16-18 hours. Five grams amount to about 100,000 eggs.

20 - While the eggs are hatching, the media is made ready to receive the newly-hatched larvae. Here is a meat shredder which slices and shreds

the meat preparatory for mixing with blood, water and formaldehyde. To rear 50 million flies each week, it requires 40 tons of ground whale or horsemeat, 4,500 gallons of bovine blood, 350 pounds of formaldehyde and 9,600 gallons of water. The young larvae are more sensitive to diet, so a mixture of ground horsemeat and blood serum is used to start them. Later, horsemeat, then whale meat, both mixed with whole blood, are substituted.

21 - This is the appearance of the rearing vat to which freshly-prepared food has been added. The mixture becomes dark in color as it gets older. The larvae feed completely buried except for their rear ends, much as in wounds of animals.

22 - As the media is used up, the expended material is siphoned off and new media added.

23 - As the larvae reach full growth, the vats have arrived at the area over the grates leading to the funnel openings. As the full-grown larvae crawl over the sides of the vats, they drop through the grates into the funnels to the lower floor.

24 - This diagram indicates the layout of the first floor. The white "X's" show the position of the funnels leading from the upper level. The red lines, indicating powered monorails can be compared with the amount of hand operated monorails. Note the position of the pupae holding room and the grouping of other processes. The powered monorails are timed so the particular portion of the insects life cycle is completed by the time the

The next preliminary for mixing with blood, water and formaldehyde. In
year 50 million liters each week, it requires 50 tons of ground shells or
potassium, 1,500 gallons of boiling blood, 350 pounds of formaldehyde and
2,000 gallons of water. The young larvae are more sensitive to this, as
a mixture of ground potassium and blood serum is used to start them.
Later, potassium, then whole meat, both mixed with whole blood, are
administered.

21 - This is the appearance of the growing vat in which freshly-prepared
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into the tunnels to the lower floor.

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"1's" show the position of the tunnels leading from the upper levels. The
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the grouping of other processes. The powered monorails are lined up the
particular portion of the insect life cycle is completed by the time the

unit arrives at the next processing point.

25 - Funnels collect larvae from the floor above. Larvae fall into trays of sand on an endless belt. The larvae pupate in the sand.

26 - This shaker machine separates the pupae and any unpupated larvae from the sand. The pupae and larvae move toward the lower end of the screen where they drop onto another screen.

27 - The screen on this separator has large enough mesh for the larvae to wriggle through but the pupae remain on the screen. In the lower foreground you see the funnel opening through which the larvae drop into the sand tray for further holding until they pupate. The pupae are carried on down the endless screen which moves on rollers. As they roll off the end they are collected and measured into trays for holding until they are ready for irradiating.

28 - The pupae are stored under controlled temperature and humidity for $5\frac{1}{2}$ days. About 18,000 pupae are stored in each of the screen-bottom trays--72 trays per rack. The pupae are moved through this $5\frac{1}{2}$ day period on a monorail until ready for exposure to radioactive cobalt.

29 - To irradiate the flies, about 3 quarts, or 18,000 pupae, are placed in a canister shown being filled here. A cardboard cap is placed over the open end. The canister is then passed through a security drawer into the cobalt room.

30 - Here is a diagram of the cobalt room with the adjacent room for

will arrive at the next processing point.

25 - Furnace collect leaves from the floor above. Leaves fall into trays of sand on an endless belt. The leaves pass to the sand.

26 - This station machine separates the paper and any suspended leaves from the sand. The paper and leaves move toward the lower end of the screen where they drop into another screen.

27 - The screen on this separator has large enough mesh for the leaves to vibrate through but the paper remains on the screen. In the lower foreground you see the funnel opening through which the leaves drop into the sand tray for further holding until they pass. The paper are carried on down the endless screen which moves on rollers. As they roll off the end they are collected and measured into trays for holding until they are ready for irradiating.

28 - The paper are stored under controlled temperature and humidity for 24 days. About 18,000 paper are stored in each of the screen-bottom trays. 72 trays per rack. The paper are moved through this 24 day period on a conveyor until ready for exposure to radioactive cobalt.

29 - To irradiate the film, about 3 quarts, or 12,000 paper, are placed in a container shown being filled here. A cardboard can is placed over the open end. The container is then passed through a security drawer into the cobalt room.

30 - Here is a diagram of the cobalt room with the adjacent room for

packaging the irradiated pupae. This room contains 6 casks of radioactive cobalt, the largest nuclear energy installation in use by the USDA. The casks were installed and carefully checked for safety by nuclear energy specialists, before operation. Outside the building are two cisterns into which casks can be lowered for repairs.

31 - One of 6 casks of radioactive cobalt used on the program. The hoist directly in front of the men is used to carry the canister of pupae from that position to a point over the cask, where it is lowered into the irradiation chamber. The pupae are irradiated for about 10 minutes, or long enough for them to receive 8000 roentgens. The canister is then withdrawn from the chamber, returned to the operator, and placed on an endless belt which carries it into the packaging room. The flies are not radioactive any more than ^{you} are after being X-rayed.

32 - This is a diagram showing a cross-section of the radioactive cobalt cask and the arrangement of the mechanical manipulator.

33 - When a canister of pupae is received in the packaging room, the pupae are poured into this hopper which automatically measures the required number of pupae into each box. The boxes have dividers similar to those of an egg carton.

34 - This machine, automatically measures and releases the required number of pupae into each box, folds and locks the boxes, and feeds them onto the table in the foreground where they are placed on trays.

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34 - One of 6 cases of radioactive cobalt used on the program. The holes directly in front of the case is used to carry the container of paper from that position to a point over the case, where it is lowered into the irradiation chamber. The paper is irradiated for about 10 minutes, or long enough for them to receive 5000 roentgens. The container is then withdrawn from the chamber, returned to the operator, and placed on an endless belt which carries it into the packaging room. The films are not radioactive any more than after being X-rayed.

35 - This is a diagram showing a cross-section of the radioactive cobalt tank and the arrangement of the mechanical manipulator. When a container of paper is received in the packaging room, the paper are poured into this hopper which automatically measures the required number of pages into each box. The boxes have dividers similar to those of an abacus.

36 - This machine, automatically measures and releases the required number of pages into each box, folds and inserts the boxes, and leads them onto the table in the foreground where they are placed on trays.

35 - The trays of boxes containing the pupae are held in a storage room at controlled temperature and humidity until the flies emerge. A few hours later they are ready for distribution over the eradication area.

36 - The trays of boxes on racks give the flies good ventilation with a minimum of space required for storage.

37 - After irradiation, a certain number of pupae from each canister is taken and a control, or daily laboratory testing, is maintained to make certain that all flies from the canisters are sterile and that the proper number are capable of emerging from the pupae. Part of this control procedure is being performed here.

38 - Once the flies have emerged in the boxes, they are loaded directly onto the aircraft as shown here. Others are transported in air-conditioned trucks to airfields at distant points.

39 - The airplane is equipped with a device which automatically ejects the box and at the same time opens it, releasing the flies. The method of feeding boxes into the release device is shown.

40 - This is the release device as it appears outside the airplane.

41 - ^{is} ~~This~~ airplane releasing a box ^{of flies}. The first small black spot nearest the airplane is the divider and the second the box itself.

42 - Here an inspector fills out the proper forms to clear a shipment of cattle destined for outside the eradication area. The State of Florida maintains a quarantine line in central Florida and the Federal Government

35 - The trays of boxes containing the pupae are held in a storage room at controlled temperature and humidity until the fifth emergence. A few hours later they are ready for distribution over the eradication area.

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37 - After irradiation, a certain number of pupae from each container is taken and a control or daily laboratory testing is maintained to make certain that all flies from the containers are sterile and that the proper number are capable of emerging from the pupae. Part of this control

procedure is being perfected here.

38 - Once the flies have emerged in the boxes, they are loaded directly onto the airplane as shown here, where they are transported in air-conditioned trucks to airports at distant points.

39 - The airplane is equipped with a device which automatically ejects the box and at the same time opens it, releasing the flies. The method of feeding boxes into the release device is shown.

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41 - The airplane releasing a box. The first small black spot nearest the airplane is the divider and the second the box itself.

42 - Here an inspector fills out the proper forms to clear a shipment of cattle destined for outside the eradication area. The State of Florida maintains a quarantine line in central Florida and the Federal Government

has several inspection stations at the eastern borders of Louisiana and Arkansas.

13 - Livestock moving from screwworm-infested regions are treated at inspection stations with an approved insecticide called CO-RAL. This permits normal livestock trade and protects the eradication area from reinfestation.

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13 - Livestock moving from summer-infested regions are treated

at inspection stations with an approved insecticide called DDT-50. This

prevents summer livestock ticks and protects the stockmen from

infestation.